3D digital documentation as a basis for the finite element method in the restoration of Tullio Lombardo's marble sculpture of *Adam*

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ABSTRACT

On October 6th 2002, one of the most important Italian Renaissance sculptures outside Italy tragically fell from its pedestal to the ground at The Metropolitan Museum of Art. The late 15th-century marble Adam by the Venetian sculptor Tullio Lombardo shattered into 26 major fragments. This paper describes the use of Laser-based methods for three-dimensional imaging, the finite element method, and the various ways the scanned data was organized to produce physical and virtual models of Tullio Lombardo's marble sculpture of Adam, for documenting, visualizing and testing finite element methods to support the effort of its restoration. Laser-scanned data collected from the 26 major fragments offered virtual geometric representations of the broken sculpture and provided a basis for creating finite element models of the sculpture. At the time, there were no precedents for a stone sculpture of this complexity being digitized for the purpose of finite element studies. The structural finite element studies described in this paper utilized digital models constructed from the original laser-scanned point cloud data, stereolithography polygon mesh files and NURBS surfaces. The studies compare results based on these different geometric representations. Finite element studies provided an opportunity to understand stress behavior present in the sculpture prior to restoration. The studies have established the total load carried across the carved surfaces and have determined the relationship between the loads and stresses present in the sculpture prior to restoration.

The results of the finite element studies have contributed important information necessary to determine the optimal properties for structural supports *a priori* which will be considered in the restoration of Tullio's Adam.